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News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Building 101, Room E215, Gaithersburg, MD 20899-2500; telephone: (301) 975-3577.

BEWARE CRIMINALS! NIST UNIFIES DIFFERENT BALLISTICS ID SYSTEMS

Crimefighting might have been elementary for Sherlock Holmes, but today's law enforcement professional depends on the speed, accuracy and nearly unlimited access to data provided by his or her computer. Sometimes, however, there can be too much of a good thing.

Both the Federal Bureau of Investigation (FBI) and the Bureau of Alcohol, Tobacco, and Firearms (ATF) use computerized systems to compare digitized pictures of unique scratches and imperfections on fired bullets or spent cartridges to similar images in a massive computer database. Matches link bullets or cartridges to a specific gun, providing solid leads that may help identify criminals.

Unfortunately, the FBI's Drug-Fire and the system supported by the ATF, called IBIS (for Integrated Ballistics Identification System), are not compatible. Among the problems: different lighting used to photograph forensic samples and different mathematical algorithms used to analyze the images, so NIST was called upon to bridge the gap.

To address the major obstacle separating the two systems, NIST specified how the IBIS and Drug-Fire manufacturers could include the other's photographic lighting as an option. Now, an IBIS setup can produce data that can be assessed by a Drug-Fire counterpart, and vice versa. With this accomplishment in hand, NIST is finalizing a standard to address the dual-system capability and will complete tests later this year to ensure interoperability.

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VIRTUAL REALITY (VR) SYMPOSIUM REALLY TAKES PLACE IN NOVEMBER

Within the last decade, virtual reality the ability of computers to recreate environments and situations so that they are sensed as real by human participants has exploded into our lives. Things as diverse as simulated field training for the military, interactive videos for the classroom and telepresence systems connecting laboratories are among VR's recent successes.

Industrial applications of VR, such as tele-collaboration, training, information management, product/process design and reengineering, and factory/production line design, are making their impact on how businesses operate. At the upcoming Industrial Virtual Reality Symposium on Nov. 1-2, 1999, at the University of Illinois at Chicago, one can learn about new developments in this exciting area and find out how research institutions and companies are contributing to the evolution of the technology and its applications.

Symposium topics include computational aspects of VR applications in manufacturing, current state of software technologies, current state of hardware technologies, distribution and logistics applications in manufacturing, layout and location applications in manufacturing, manufacturing education, manufacturing process design, product design and prototyping, telepresence and tele-robotics, and volumetric visualization.

The symposium is hosted by NIST and the University of Illinois at Chicago. It is the sister event to the American Society of Mechanical Engineers Symposium on Virtual Environments for Manufacturing at the ASME International Congress and Exposition in Nashville, Nov. 14-19, 1999.

For more information on the symposium, check out http://www_ivri.me.uic.edu/ on the World Wide Web. To register, contact Lori Phillips Buckland, NIST, 100 Bureau Dr., Stop 3461, Gaithersburg, MD 20899-3461, (301) 975-4513, lori.phillips@nist.gov.
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DRAFT STANDARD SPEAKS VOLUMES FOR FUTURE E-BOOK SUCCESS

Electronic books are hybrid products that combine the printed word with the versatility of computer, touch-screen display technology, and software enhancements including font-resizing and an on-board dictionary. The Open Electronic Book Standards Forum recently released a draft specification in a move that is expected to accelerate the availability of e-books by providing publishers a single format for electronic content.

The group was formed in October 1998 at NIST's Electronic Book '98 Workshop, the world's first conference for the e-book industry.

A NIST staff member spearheaded the effort to bring industry groups together to create a voluntary, common standard. Participants included more than 100 major software companies, book publishers and electronic book manufacturers.

Common standards are particularly important in emerging industries because they free consumers from the fear of investing in new technologies that could become obsolete. When a variety of industry participants agree on a standard, consumers can choose products from any manufacturer that supports the standard, facilitating early adoption and market definition.

The new draft standard delineates the format that content takes when it is converted from print to electronic form. It calls for the use of two common computer mark-up languages—HTML and XML—which are widely used on the World Wide Web.

More information about the standards effort and a copy of the draft specification are available at www.openebook.org. The next e-book conference, Electronic Book '99, is scheduled for Sept. 21-22, 1999, at NIST in Gaithersburg, MD. For more information, go to www.nist.gov/ebook99.
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MAGNETIC RECORDING INDUSTRY TO BENEFIT FROM NEW PARTNERSHIP

NIST is working to provide the magnetic recording industry with much-needed primary magnetic materials standards. Unfortunately, these reference samples are expensive, delicate and generally of fixed geometry. To help the industry out, NIST has signed a cooperative research and development agreement (CRADA) with a private company, to develop calibration principles for robust, inexpensive reference samples.

For example, instruments that measure *B-H* loops are the dominant metrology tool used by the disk drive head industry for process and quality control at the wafer level. A prototype for the calibration of such instruments will be designed, constructed and tested as a secondary reference sample. This will complement the primary thin film reference sample currently under development at NIST. Measurements on soft magnetic films, as used in heads, sensors and magnetic RAM devices, will be improved with the implementation of these secondary reference samples.

More information on this CRADA may be obtained from David P. Pappas, NIST, Boulder, CO 80303-3337; (303) 497-3374; david.pappas@nist.gov; or Barry Megdal, SHB Instruments Inc., 19215 Parthenia St., Suite A, Northridge, CA 91324; (818) 773-2000; bmegdal@sbhinstruments.com.
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NASA ADOPTS STEP STANDARD FOR DATA EXCHANGE

International Standard ISO 10303, standard for the exchange of product model data (STEP), received one of its strongest endorsements to date when the National Aeronautics and Space Administration (NASA) recently required all of its computer-aided engineering, design and manufacturing systems to have STEP-compliant tools that enable data interchange.

From the definition of IGES (the Invited Graphics Exchange Specification) through the current STEP standard, NIST has been a leader in the quest to create a universal, unambiguous language for exchanging product information. From 1984 until 1998, NIST also served as the secretariat for the International Organization for Standardization (abbreviated ISO) Subcommittee on Industrial Data. NIST still participates in STEP's evolution and implementation by developing testing methodologies for and making technical contributions to ISO 10303 as applied to different industries.

Both NASA and NIST are members of PDES Inc., a joint industry/government consortium specifically formed to accelerate the development and implementation of STEP. The general manager of PDES Inc., said, "The release of this [NASA] standard is a real milestone for the STEP community. It basically says that if you want to exchange data with NASA, ISO 10303 is the way to do it."

For more information on NIST's involvement in STEP, contact Lisa Phillips, (301) 975-5021; lisa.phillips@nist.gov; or Steven Ray, (301) 975-3524; steven.ray@nist.gov. For more information on NASA's new STEP standard, contact Steve Waterbury, Goddard Space Flight Center; (301) 286-7557; steve.waterbury @gsfc.nasa.gov. For PDES information, contact Martha Nicholson, (843) 760-3225; nicholson@aticorp.org.
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NEW NVLAP DIRECTORY LISTS ACCREDITED LABS

More than 700 testing and calibration laboratories accredited by the NIST National Voluntary Laboratory Accreditation Program (NVLAP) are listed in the just-issued *NVLAP 1999 Directory.* Operating in 47 states, Puerto Rico and eight foreign countries, the listed laboratories together offer 850 services that were judged by NVLAP to satisfy internationally accepted competency requirements.

At the request of industrial and government organizations, NVLAP has set up accreditation programs in 18 major fields. Also available on NVLAP's World Wide Web site (ts.nist.gov/nvlap), the new directory indexes laboratories by accreditation field, name, location and NVLAP identifier code. Entries list street and website addresses, contacts, field and scope of accreditation, and other information. With nearly 400 accredited laboratories, asbestos fiber analysis accounts for the largest group of NVLAP-accredited services, followed by computer and electronics testing.

Thanks to NVLAP, the test results from many of the labs listed in the new directory will have international impact. New trade agreements between the U.S. government and the European Union and several Asia-Pacific nations rely on mutual recognition of test results. NVLAP has entered into a mutual recognition arrangement with seven other Asia Pacific countries and is working toward similar recognition by European nations that signed another multilateral agreement. Mutual recognition arrangements will reduce double testing, which adds to the cost of traded goods.

To get a copy of the *NVLAP 1999 Directory,* contact NVLAP at (301) 975-4016; fax: (301) 926-2884; nvlap @nist.gov.
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INTERNATIONAL COMPARISON OF CHARPY PROGRAMS SHOWS GOOD AGREEMENT

Charpy impact testing is often specified as an acceptance test for structural materials, and companies performing these tests are required to verify the performance of their machines using certified specimens. In the first ever group comparison, detailed in a NIST Report, the Charpy impact verification programs offered by the United States, Japan, France and the European Commission showed good agreement.

Certified specimens for Charpy testing are obtainable only from the Institute for Reference Materials and Measurements (Belgium), Laboratoire National D'Essais (France), the National Research Laboratory of Metrology (Japan) and NIST (United States). About 1800 impact machines are verified annually from these specimens. The comparison showed the certified energies of the specimens typically agreed within 1 % of the average values determined in the study. The variation in energy for the specimens was low, and the energies measured for the tests using the 2 mm and 8 mm strikers on specimens of 4340 steel were nearly equivalent. However, a trend of slightly higher energy for the 2 mm striker was indicated.

"The good agreement shown by the comparison implies that industries verifying the performance of Charpy impact machines to the requirements of ISO 148-2 can be assessed in a fair and meaningful manner, independent of who supplies the specimen," the NIST report states.

Copies of report No. 19-99 are available from Sarabeth Harris, MC 104, NIST, Boulder, CO 80303-3337; (303) 497-3237; sarabeth@boulder.nist.gov.
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NCWM ANNUAL MEETING TO ADDRESS IMPROVED HANDBOOK 133

Weights and measures experts from government and industry met in Burlington, VT in July 1999, for the 84th annual meeting of the National Conference on Weights and Measures. This year's theme was "Setting Standards of Excellence in Pursuit of Equity." Attendees had the opportunity to discuss a draft of a new, easier-to-use NIST Handbook 133, *Checking the Net Contents of Packaged Goods,* and other issues related to regulatory weights and measures activities. Participants also had the opportunity to hear a special presentation on the

recent activities of the Asia-Pacific Legal Metrology Forum and attend a series of technical sessions, including one on an undercover investigation of retail motor-fuel dispenser fraud.

Among those encouraged to attend were state weights and measures directors, state and local weights and measures inspectors, industry representatives, federal agency representatives, allied organizations, consumer organizations, retailers, and food processing industry representatives.

Information on the NCWM is available by calling (301) 258-9210 or by visiting www.nist.gov/ncwm on the World Wide Web.

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NIST PORTABLE VOLTAGE STANDARD FEATURED IN AEROSPACE INDUSTRY PUBLICATION

In the April 26, 1999, edition of *Aviation Week & Space Technology,* NIST researchers were recognized for their work on the development of a fully automated portable Josephson voltage standard. After citing the relative uncertainty of measurements with the system of less than 2×10^{-8} as being equivalent to that of a full Josephson voltage standard calibration system, the article notes that the portable system can be shipped by overnight courier, and assembled and operated in less than an hour—"Further, accuracy is not sacrificed."

The article also states that prior to the development of the portable standard, ". . . research laboratories had to either send their voltage standards to NIST or install their own Josephson voltage standard calibration system—a difficult and time-consuming effort." The portable system uses a cryophobe to cool the voltage chip, which has 20 208 superconducting Josephson junctions. A laptop computer and electronic package control the system. The package, excluding the computer, is only 13 cm×48 cm and weighs a mere 21 kg. The article estimated that "They should reduce the uncertainty at NASA and Energy Department laboratories by a factor of 10." This work was done in collaboration with Sandia National Laboratories.

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NIST REPORT ASSESSES TESTING STRATEGIES FOR EFFICIENCY TESTING OF DISTRIBUTION TRANSFORMERS

As part of its energy efficiency program, the Department of Energy (DOE) is developing efficiency standards for distribution transformers. Different testing strategies and sampling plans to determine compliance of a companys product have been proposed by DOE and by the manufacturing industry. The choice of the proper sampling plan (a guide for how many units are tested and for how many tests are performed) is important to ensure compliance of a manufacturers product line without putting undue burden upon the manufacturer by requiring excessive testing.

Staff from NIST have been working with the Department of Energy to evaluate the potential sampling plans for the testing of efficiencies for distribution transformers. This study has determined the impact of various sampling plans on both the manufacturers of transformers and on the probabilities of compliance. The results of this study have been recently published in NIST Technical Note 1427, *An Analysis of Efficiency Testing Under the Energy Policy and Conservation Act: A Case Study with Application to Distribution Transformers*.

The report includes a statistical analysis of the sampling plans for efficiency testing promulgated by Title 10 of the Code of Federal Regulations (10 CFR), Part 430, which was established under the Energy Policy and Conservation Act of 1975, as amended, for application to distribution transformers and certain consumer products. The report presents calculations that model the probability of demonstrating compliance and the average number of units tested under the Part 430 sampling plans. Potential sampling plans for distribution transformers are presented in the proposed new 10 CFR Part 432 (*Federal Register,* Vol. 63, No. 218, 1998, pp. 63360-63372]) and in NEMA Standards Publication TP 2-1998, *Standard Test Method for Measuring the Energy Consumption of Distribution Transformers*. Model calculations for each of these sampling plans are presented in the report, along with an assessment of the implications of each plan. This work was sponsored, in part, by the Department of Energy, Office of Energy Efficiency and Renewable Energy.

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NIST'S DEVELOPMENT OF AN ADVANCED ENCRYPTION STANDARD REACHES NEW MILESTONE

NIST's efforts to develop an Advanced Encryption Standard (AES) reached another milestone on April 15, 1999, with the closing of the public comment period on the 15 candidate algorithms. These algorithms had been announced by NIST in August 1998, accompanied by an invitation for public review and analysis. In response to this request, cryptographers, researchers, and crypto-

graphic implementers from around the world studied and analyzed the candidates and provided input to NIST on the security, efficiency, intellectual property, and other factors about the algorithms.

NIST received approximately 60 public comments and about 30 papers submitted for NISTs Second AES Candidate Conference, held in March 1999, in Rome. At the NIST-sponsored conference, members of the worlds cryptographic community gathered to discuss and critique the candidates. The submitters of each of the algorithms also were given the opportunity to respond to comments made about their algorithms. Conference papers and comments are available on the AES home page at http://www.nist.gov/aes.

Using the conference papers, public comments, and the results of its own analysis of the algorithms, NIST has begun the process of narrowing the field of candidate algorithms to (approximately) five finalists. NIST will accept public comment on and analysis of the finalists from the time they are announced in the summer of 1999 until May 2000. The Third AES Candidate Conference has been tentatively scheduled for April 2000 in New York to discuss the analysis of the final candidate algorithms. When available, details will be posted on the AES home page.

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NIST'S CRYPTOGRAPHIC MODULE VALIDATION PROGRAM VALIDATES 50TH MODULE

The Cryptographic Module Validation Program (CMVP) run by the U.S. and Canadian governments achieved a significant milestone recently as it issued the programs 50th certificate. The 50th certificate was issued to RSA Data Security, Inc., for their BSAFE Crypto-C development product. This product has been validated successfully as meeting the requirements of Federal Information Processing Standard (FIPS) 140-1, Security Requirements for Cryptographic Modules.

The FIPS 140-1 Validated Modules List is quickly becoming a whos who of cryptographic and information technology vendors and developers from the United States, Canada, and abroad. The list contains a complete range of security levels and a broad spectrum of product types including secure radios, internet browsers, cryptographic accelerators, secure tokens, and others. The recent validations affect federal agencies by further in creasing the number of cryptographic products available for use in securing sensitive information. Approximately 50 new modules are currently in the testing phase of validation.

At the May 1999 Communications Security Establishment (CSE) Computer Security Symposium, two private companies discussed the importance of FIPS 140-1 validation testing, the increases in security from the validation process, and the positive impact that validation had on their marketing efforts.

The CMVP is a joint effort between NIST and CSE, which serve as the validation authorities for the program. Currently, there are three National Voluntary Laboratory Accreditation Program accredited laboratories that test cryptographic modules.

For more information on FIPS 140-1, validated modules, and the accredited laboratories, see the web site at http://csrc.nist.gov/cryptval.

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NIST FIRE EXPERIMENT FEATURED AT DELAWARE STATE FIREFIGHTER APPRECIATION DAY

The Delaware State Legislature invited NIST fire researchers to participate in Delaware State Firefighter Appreciation Day activities, which were held in front of the state capitol. NIST researchers conducted an experiment in a furnished living room to demonstrate how rapidly a hazardous fire can develop in a home, as well as measure the thermal exposures that fire fighters encounter when fighting a residential fire. More than 40 000 firefighters are injured each year combating residential fires. Approximately 200 observers, including Governor Carper and a host of fire officials, witnessed the experiment. A sofa ignited with a match developed into a deadly flashed-over room fire within 3 minutes. The experiment was conducted as part of NISTs Advanced Fire Fighting Technology Project.

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CRYSTAL STRUCTURES IN ULTRATHIN MULTILAYERED MATERIALS

NIST researchers reported recently in *Physical Review Letters* and the *Journal of Materials Research* that some of the unusual crystal structures reported in the literature for thin multilayers are artifacts of the way in which the materials have been prepared for microscopic examination. When ultrathin layers of a material are deposited on a substrate, the crystalline structure often differs from that normally observed in the bulk material. For example, titanium (Ti), which at room temperature normally has a hexagonal close packed (hcp) crystal structure, can deposit from the vapor with

a face centered cubic (fcc) structure in extremely thin films, but it reverts to the normal hcp structure in thicker layers. Reports in the literature have claimed, on the basis of observations in the transmission electron microscope (TEM), that the fcc phase of Ti was stable in relatively thick multilayers, in which alternating thin layers of Ti and aluminum (Al) were deposited. In addition, it was claimed that the Al in multilayers had the hcp form instead of its normal fcc structure, and it was suggested that a material with these novel structures might have improved mechanical properties. Attempts to interpret these unusual structures, however, were thwarted by inconsistencies between TEM and x-ray diffraction (XRD) structural measurements.

The NIST researchers fabricated nanoscale multilayers by electron beam evaporation, with alternating layers of Ti and Al 7.2 nm and 5.2 nm thick, respectively. To investigate the important issue of crystal structure in these materials, they applied several different techniques, including reflection and transmission x-ray diffraction (XRD) as well as transmission electron diffraction (ED), high-resolution TEM, and energy-filtered TEM. XRD examines the material in the as-deposited state, and it revealed that both the titanium and the aluminum in the multilayers had their normal bulk forms (hcp and fcc, respectively). TEM, however, requires that a very thin cross-section of the multilayer be prepared, so that the layers can be viewed edge-on. TEM observation by the NIST researchers of the thinned cross sections revealed that the Ti had transformed during the thinning process from the hcp structure observed by XRD to the fcc structure.

The NIST work thus showed that the novel structures reported to exist in relatively thick multilayers could actually be just an artifact of the sample preparation method. The NIST results indicate the caution necessary in interpreting measurements of unusual properties of thin films.

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NEUTRON FOCUSING WITH COMPOUND REFRACTIVE OPTICS DEMONSTRATED AT THE NIST CENTER FOR NEUTRON RESEARCH (NCNR)

Since refractive indices for cold neutrons (wavelength $\approx$ 1 nm) differ from unity by at most a few times 10^{-5}, grazing incidence reflection optics long have been considered the most promising means for focusing neutrons for applications such as small-angle neutron scattering (SANS). Numerous attempts over more than 30 years to produce reflective surfaces for neutrons have been vitiated, however, by SANS from the mirror surfaces themselves, which blurs the focus. The best mirrors produced thus far are only marginally better for SANS than pinhole collimation, i.e., simple apertures separated by long distances.

Scientists at a private laboratory recently took a fresh look at this problem and proposed that multiple refraction from high index, low absorbing material could be superior to reflection optics or conventional pinhole collimation for SANS. Measurements made recently at the NCNR in collaboration with the scientists at the private laboratory have demonstrated that this is indeed the case. Using a linear array of 28 biconcave magnesium fluoride lenses, a beam of 0.85 nm neutrons, from a source aperture 15 m from the lenses, was focused onto a detector 15 m away. Most importantly, parasitic scattering from the lenses was 10 000 times less than the peak intensity, a marked improvement over reflection optics.

Actual SANS measurements made with the focusing lens system at the NCNR have demonstrated more than an order of magnitude improvement in sensitivity to structural features in materials 50 % larger than has been possible using pinhole collimation. Plans are now under way to install lens systems in the SANS instruments for routine use whenever the highest resolution measurements are required. The researchers expect this new capability to have a great impact on SANS studies of microstructure in materials as diverse as polymer composites and high-T_c superconductors.

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NEW VAMAS TECHNICAL WORKING AREA ESTABLISHED

A new Technical Working Area (TWA) with the title Thermal Properties of Thin Films has been established under the Versailles Project on Advanced Materials and Standards (VAMAS). The objective of the TWA is to evaluate measurement methods for determining thermal properties of thin ceramic films and coatings. The initial emphasis of the TWA is on thin-film thermal conductivity. Few techniques are available for this measurement, and the reliability and uncertainty in these techniques has not been established. A recent workshop indicated that there is no consensus regarding the relationship between thin-film thermal conductivity and bulk

thermal conductivity. In order to model systems that depend on the transport of heat through thin films, one must be able to perform measurements of thermal conductivity that minimize measurement uncertainty. While many techniques measure thermal diffusivity, it is important to measure thermal conductivity because this is the property of direct interest.

A round robin has been organized as the first TWA activity. The goal is to evaluate different methods of measuring thin-film thermal conductivity. Eighteen laboratories from the United States, Japan, Germany, China, and Korea have agree to participate. The specimens consist of silicon dioxide films on silicon substrates, produced by oxidation of the silicon. The films have nominal thicknesses of 50 nm, 100 nm, 200 nm, and 500 nm. The results of the round robin are now being evaluated.

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SOFTWARE TOOL FOR OPTIMIZED HEAT EXCHANGER DESIGN

The goal of a heat exchanger design engineer is to obtain the maximum capacity for specified general heat exchanger parameters. One of the important design tasks for a finned-tube heat exchanger design is designing refrigerant circuitry, i.e., specifying the refrigerant path through the heat exchanger assembly. Designing an optimized circuitry is particularly challenging when a zeotropic mixture is used as a refrigerant or when the air entering the heat exchanger has a non-uniform velocity profile.

A NIST scientist in cooperation with university scientists demonstrated the feasibility of designing an optimized refrigerant circuitry without designers input using a dedicated software package. The package consists of NISTs detailed tube-by-tube evaporator model, EVAP5, and the learnable evolution module the scientists developed. During a refrigerant circuitry design run, the module generates a population (set) of proposed circuitry architectures for which EVAP5 evaluates as to the obtained capacity. The results guide the module in generating the next population for evaluation by EVAP5. This process can be repeated hundreds of times and leads to an optimized design. The studied cases showed that the developed software package can design an optimized circuitry for both R-22 (a single-component refrigerant) and R-407C (a ternary zeotropic mixture) in cases involving uniform and non-uniform air distribution.

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INDUCTIVE SYSTEM USED TO MEASURE FREQUENCY DEPENDENCE OF PERMEABILITY

NIST researchers demonstrated the possibility of obtaining the frequency dependence of permeability from the inductive time-response signal of magnetic films on coplanar waveguides. Because the measured inductive signal is proportional to the time derivative of the magnetization response to a step-function drive field, the Fourier transformation of the measured time response represents the frequency dependence of the complex permeability.

The technique is simple and only the applied external bias field limits the frequency response because it determines the resonance frequency. For typical bias fields of several hundred ampere per meter, a frequency response of up to several gigahertz can be obtained. The technique does not require a special coil set or special yoke design. Simple coplanar waveguides with a wide-band sampling oscilloscope are used. The calibration and application of the technique is much simpler than the procedure used in other permeameters. Commercially available systems currently have a frequency range of only 500 MHz. The NIST inductive technique, with a bandwidth of 3.5 GHz, is a great improvement. Comparisons with traditional measurements performed at the University of Alabama show good agreement.

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PATENT DESCRIBING NEW METHOD OF SPECTROSCOPIC MATERIALS ANALYSIS AWARDED TO NIST RESEARCHERS

Four NIST researchers, along with industry colleagues, recently learned that their method of spectroscopic analysis had been awarded U.S. Patent Number 5, 880, 467 (NIST #96 034US). Their patent describes a new method of spectroscopic materials analysis in which a sample under test is bombarded by electrons in a scanning electron microscope to produce an x-ray emission collected over a large solid angle by a poly-capillary lens and focused onto the surface of a microcalorimeter detector. The x-ray lens is used to increase the effective collection area of the microcalorimeter detector used in an x-ray spectrometer. By increasing the collection angle, the time period for x-ray collection is reduced and the detector can be located farther from the x-ray source. The x-ray lens is effective over a broad energy range of x rays, thus providing compatibility with spectroscopic analysis. The microcalorimeter can be calibrated to compensate for any variations in the transmission efficiency of the x-ray lens.

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NIST RESEARCHERS AWARDED PATENT FOR METHOD AND APPARATUS FOR PARTICLE DETECTION

Two NIST researchers recently received notice that their patent application for a superconducting transition-edge sensor has been approved. This invention provides a method and apparatus for particle detection using an Al/normal-metal bilayer transition-edge sensor (TES) coupled with a particle absorber. The TES is maintained in the transition region where its properties are extremely sensitive to temperature. In the detector, the energy of an absorbed particle is converted to heat by the absorber and the transition from the bilayers superconducting to normal state is used to sense the temperature rise. The transition temperature T_c, of the bilayer can be reproducibly controlled as a function of the relative thicknesses and the total thickness of the superconducting and normal-metal layers. The range of available T_c's extends from below 50 mK to above 1 K, allowing the detector to be tailored to the application. For x-ray detection the preferred T_c is about 50 mK to 150 mK. The width of the transition edge can be less than 0.1 mK, which allows very high detector sensitivity.

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"RENEWABLE POLISHING LAP" AWARDED PATENT

The renewable polishing lap virtually eliminates the substantial time and expense for "renewing" traditional laps. This new manufacturing process technology enables manufacturers to reduce drastically the costs for a wide variety of grinding, lapping, and polishing operations. The U.S. Patent Office has awarded U.S. Patent Number 5,897,424 "Renewable polishing lap" to a NIST scientist and a guest worker, for the development of the renewable polishing lap. The renewable polishing lap uses a textured substrate over which a thin film is placed. The substrate provides the geometry of the lap and a localized texture, which depends on the film thickness, properties, and means by which the film is deformed over and adhered to the substrate. When abrasives are distributed over the film, the substrate is protected during the lapping or polishing action. Since the film protects the substrate from the harsh abrasives, the substantial time and expense typically required for renewing the lap is eliminated. The renewable polishing lap technology has been licensed to a private company, which is developing the technology for use in photomask blank polishing.

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LINEWIDTH MEASUREMENT COMPARISONS MADE

NIST scientists recently completed the first phase of an intercomparison between the scanning electron microscope (SEM), the calibrated atomic force microscope (C-AFM), and electrical critical dimension (ECD). In this study, a single crystal Si line with vertical sidewalls was used as the test specimen. The latest instrument models to correct all three measurements also were utilized. In this carefully controlled experiment, all three techniques yielded results that agreed within their assigned uncertainties. In summary, the SEM found the prescribed line to be 447 nm ± 5 nm; the AFM found it to be 449 nm ± 13 nm, and the ECD technique obtained 438 nm ± 34 nm. This demonstrates that when properly done the methods can agree, at least for a good sample. Differences between ECD and SEM for optical linewidth are a widely acknowledged problem among industrial metrologists. For example, differences of 20 nm to 40 nm for linewidths observed in polysilicon between ECD and other techniques are common. Published documentation and systematic studies are scarce in this area, but published papers have documented ≈ 90 nm differences for chromium lines.

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NOVEL APPROACH IMPLEMENTED TO CAVITY RING-DOWN SPECTROSCOPY

NIST researchers have implemented a novel approach to cavity ring-down spectroscopy (CRDS) using pulsed lasers. The ring-down method exploits the finite lifetime of light within an optical resonator, which is manifest as an exponential decay of the photon flux exiting the cavity. This lifetime measurement can be used to determine the presence of trace quantities of gaseous molecules, because the photon lifetime decreases as a result of light absorption within the cavity. The ring-down technique has generated significant interest as a potentially sensitive monitor of industrial processes where trace contaminants, such as water, can diminish product yields or where the non-linearities inherent to conventional instrumentation prove to be limiting.

Among practitioners of CRDS, conventional wisdom held that maximum sensitivity came from building cavities several meters in length. This intuitive notion arose because the photon lifetime scales with the cavitys length, and the longer the photon lifetime, the easier it should be to discern small changes in this quantity. However, NIST researchers developed a theoretical model that suggested using short cavities (centimeters-long) might eliminate pulse-to-pulse variability and thus maximize sensitivity. This improvement arises from the

excitation of a single optical resonance, which leads to simple and highly repeatable ring-down signals. In contrast, with a long cavity, several optical resonances are excited and interference between these resonances leads to irreproducibility in the measurement. A 10 cm long cavity was constructed to test these predictions. These experiments found that single-mode excitation increased the sensitivity more than a hundred-fold, when compared to previous experiments that had employed a cavity more than 1 m long. Moreover, the relative standard deviation calculated from an ensemble of measurements agreed with the estimated, relative standard deviation in a single measurement, unlike the longer cavity measurements. Furthermore, the relative standard deviation in the mean value of the photon lifetime was within a factor of seven of the theoretical minimum value, the shot-noise limit where the statistics of the photons exiting the cavity determines the uncertainty in the lifetime measurement. These characteristics should allow water densities of $\approx 3\times10^{8}$ molecules per cubic centimeter to be probed at near-infrared wavelengths.

These important results should have a dramatic impact on industrial applications of CRDS, where the footprint of an instrument is of paramount concern and where increased sensitivity makes the technique even more attractive as an analytical instrument. The precision of single-mode CRDS measurements also might make this method a competitive standard at high pressures. The results of these experiments appeared in the June 20, 1999 issue of *Applied Optics*.

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ELECTRICAL CONTROL OF PLASMA SPATIAL UNIFORMITY

NIST scientists have demonstrated a new method for controlling the spatial distribution of reactive chemical species in fluorinated gas plasmas. Such plasmas are used widely by the semiconductor industry to etch silicon, silicon dioxide, and silicon nitride films. They also are used to clean the reactors that deposit these films. In both etching and chamber cleaning, the spatial distribution of chemical species in the plasma is an important concern.

The method was demonstrated in CF_4/O_2 and C_2F_6/O_2 chamber-cleaning plasmas, in a plasma reactor with two electrodes. The reactor is normally operated by applying radiofrequency power to one electrode and grounding the opposite electrode. To implement the new control method, the ground connection of the second electrode was replaced by a variable-impedance electrical load. The load controls whether the radio-frequency current injected at the powered electrode flows to the second electrode or to other surfaces inside the reactor. By altering the flow of current through the plasma, one is able to control where plasma electrons are heated and reactive species are generated. This in turn allows control of the spatial distribution of reactive species, as verified by two-dimensional broadband optical emission measurements and two-dimensional planar laser-induced fluorescence of the CF_2 radical. By varying the load impedance, one can obtain greater control over the spatial distribution of reactive species, beyond what can be obtained by only varying the pressure, power, gas mixture, or flow rate. This control method potentially could be used to direct reactive species in chamber-cleaning plasmas toward the reactor surfaces most in need of cleaning, or to increase the uniformity of reactive species across the wafer surface during etching.

This work grew from previous studies on the optimization of chamber-cleaning plasmas performed in collaboration with a private company. The principles of the new control method, as well as the earlier work, are believed to be sufficiently general to apply to a wide variety of gas mixtures. Results from earlier work have been used to minimize the emission of global warming gases from CF_4/O_2, C_2F_6/O_2, and NF_3/Ar plasmas, and to maximize the etch rate of SF_6/Ar plasmas.

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MOLECULAR RESOLUTION SNAPSHOTS OF SELF-ASSEMBLED MONOLAYER DEGRADATION

Recent studies by NIST scientists have produced the first molecular resolution images of the reaction between ozone and self-assembled monolayer (SAM) films. The images clearly show regions of the monolayers that are susceptible to ozone attack and reveal the molecular-scale mechanism by which the monolayers degrade. These SAMs are alkanethiol molecules that adsorb spontaneously on gold surfaces to form crystalline, two-dimensional molecular assemblies. SAMs are used as molecular recognition elements in many chemical sensing and diagnostic devices under commercial development. For the device to operate properly, it is essential that the monolayers remain stable during normal operation. It was generally thought that alkanethiol SAMs were inert in typical laboratory environments; however, recent studies by several research

groups show that ozone present in room air degrades SAMs by oxidation of the thiol headgroup.

NIST initiated the scanning tunneling microscope (STM) studies to develop a better understanding of the process by which ozone reacts with the SAMs. Prior NIST work had developed a molecular-level understanding of the crystalline phases and defects that characterize alkanethiol monolayers. STM experiments were conducted in a controlled environment using purified ozone. To follow the time evolution of the reaction, monolayers were exposed to increasing doses of ozone while STM data were recorded. Photoelectron spectroscopy also was used to monitor the oxidation process and confirm oxidation of the thiol headgroup. Images reveal that ozone attacks the crystalline monolayers preferentially at the two-dimensional network of molecular-scale domain boundaries. With increasing ozone exposure, the reaction front propagates into the crytalline domains. The studies also reveal that, as the oxidation progresses, the crystalline monolayer discontinuously melts forming an interface film that is either a two-dimensional liquid, or a two-dimensional amorphous solid. The detailed mechanistic insights provided by these studies point to possible strategies to improve SAM stability in air such as decreasing the density of domain boundaries or decorating boundaries with molecules that are inert to ozone.

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INNOVATIVE APPROACH DEVELOPED FOR INSTRUMENTAL ANALYSIS IN THE PRESENCE OF DRIFT

Scientists at NIST have developed a simple, more efficient, approach to correct for low frequency noise, or drift, that has proved gen-erally useful for precision chemical metrology, delivering up to 20-fold precision enhancements. This approach has been demonstrated using ICP-OES (inductively coupled plasma optical emission spectrometry) and promises to make this instrumental method a primary method of measurement, competitive with classical chemical methods of analysis, such as titrimetry and gravimetry. Classical analysis is an expensive and disappearing capability in analytical chemistry because of the rigor and labor intensity required but is still highly valued by industry because of the narrow uncertainty limits provided. Thus, there is great interest in replacing this capability using analytical instrumentation to exploit the opportunities of automation and advanced computational methods.

This approach was developed for and is now a principal component of precision comparisons of spectrometric solution Standard Reference Materials (SRMs), primary materials extensively used to gain traceability to NIST in chemical measurement. Mass fraction determinations with relative expanded uncertainties of about 2×10^{-3} are typical, limited not by the instrumental measurement uncertainty but by the ability to perform precise and accurate sample handling. In the coming year, the technique will be tested in a CIPM-sponsored "key comparison" between national metrology measurement institutes for these primary standards.

The high-precision methodology has been extended to multielement applications using ICP-OES, as well as to several other instrumental techniques, including mass spectrometry and gas chromatography. A new SRM, a four-component, Ni-based high-temperature alloy, originally scheduled for classical analysis, was measured instrumentally using this technique-resolving discrepancies observed by other laboratories. In addition, NIST worked with the Department of Energy to apply the methodology in its $2 billion light-water tritium manufacturing program to ensure the tight specification of the composition of the critical ceramic target material.

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ALPHA VERSION OF BENCHMARK MULTIPHASE COMBUSTION DATABASE RELEASED

NIST researchers have constructed a reference spray combustion facility and developed a benchmark database to validate multiphase combustion models and submodels. The facility includes a stainless steel enclosure to isolate the reacting fuel spray from the surroundings and provide well-defined boundary conditions for modeling the combustion process. The baseline case consists of a swirling methanol spray flame generated with a pressure-jet atomizer. Methanol was chosen as the baseline fuel because the kinetic and thermodynamic properties required to model the combustion process are available on the NIST WebBook (http://webbook.nist.gov/).

The reacting fuel spray has been characterized using phase Doppler interferometry. The droplet size and velocity distributions, number density, and mass flux have been measured as a function of position within the spray. Fourier transform infrared spectroscopy was used to measure species concentrations in the emissions. Wall and exit gas temperatures have been measured, and the

inlet gas velocity has been characterized both experimentally and computationally to provide well-defined inlet and boundary conditions.

A preliminary data set has been released (NISTIR 6286) so that the task of modeling the spray combustion facility may begin. Several industrial partners have or are currently carrying out simulations of this reference facility. Industrial and academic collaborators interested in using the NIST database to validate computational fluid dynamics (CFD) models were invited to attend a workshop at NIST in June. The purpose of this workshop was to familiarize the modelers with NIST's reference spray combustion facility, assess preliminary findings from simulations of the NIST benchmark facility, allow modelers to express their data needs, and provide an opportunity for feedback concerning future measurements.

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INDUSTRY-GOVERNMENT TEAM PROPOSES AN INTERNATIONAL TECHNOLOGY ROADMAP FOR COMPOUND SEMICONDUCTORS (ITRCS)

At the recent "Compound Semiconductor Outlook" forum, speakers spoke confidently of the 10 % to 40 % market growth across a broad range of materials and applications. In a proactive effort to motivate increased consensus-based planning that will further accelerate the compound semiconductor industry, NIST staff collaborated with a private company to suggest a potentially ground-breaking roadmap in a recent article entitled *Do We Need A Roadmap?*, published in *Compound Semiconductor,* Vol. 5, No. 3, April 1999, pp. 43-44. The authors hope that the proposed roadmap will be as successful as the highly influential International Technology Roadmap for Semiconductors (formerly the National Technology Roadmap for Semiconductors), which many observers believe contributed significantly to the sustained and accelerated growth of the silicon semiconductor industry over the past decade.

The NIST-industry team of researchers identified 16 critical measurement and standard challenges for materials technology within the portion of the wireless communications industry concerned with compound semiconductors. Their experience led them to conclude that other industry sectors also would benefit from similar focused roadmapping efforts. The article discusses historical events and technology trends that indicate now is the time for companies in the compound semiconductor industry to begin collaborative roadmapping activities and determine key actions needed to develop the proposed ITRCS as well as metrics for assessing its impact. To increase awareness of and encourage participation in this effort, a World Wide Web site has been established for collecting and discussing ideas, comments, and questions relating to the creation of an ITRCS (http://www.eeel.nist.gov/812/itrcs.html).

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NIST PARTICIPATES IN WORKSHOP ON LOW-LEVEL RADIATION DOSIMETRY MEASUREMENTS FOR THE STATES

The United States faces a large and costly problem with sites and facilities contaminated with radioactivity from commercial and defense operations. Environmental restoration, decontamination and decommissioning, and transport of contaminated materials require accurate measurements as the basis for sound decisions. Extensive use of radiation survey measurements could be an extremely critical tool to minimize expenses associated with analytical measurements. However, current low-level measurements are not directly traceable to NIST standards, and the implementation infrastructure (i.e., some form of accreditation) is not available. The lack of traceable measurements diminishes the confidence and utility of remediation decisions that ultimately could result in costly delays in meeting cleanup-project goals, as well as public concern and possibly litigation.

A Workshop on Low-Level Radiation Dosimetry Measurements was held in May in Louisville, KY. Sponsoring organizations included NIST, the Council on Ionizing Radiation and Measurements and Standards Public and Environmental Radiation Protection subcommittee, the Conference of Radiation Control Program Directors of the states, and the Department of Energy. The meeting was attended by regulatory agencies, commercial laboratories, licensees, standards and reference laboratories, and environmental radiation metrologists.

Talks were presented on user needs, state-of-the-art environmental-level measurements, and obstacles with these types of measurements. It was agreed that NIST-traceable calibration of survey instruments would provide data generators and users with technically defensible measurements and confidence in cost-effective cleanup project decisions. A NIST scientist made a presentation on the NIST standards and traceability for environmental-level dosimetry measurements. NIST resources are sufficient for transfer calibrations to secondary laboratories. However, policy and procedures for calibrations at lower levels need to be established by some accrediting body.

Four major recommendations were made as a result of the workshop. First, there is a great need for development of an acceptable quality assurance (QA) - quality control (QC) system for survey meter usage. Second, standard procedures must either be developed, or the existing ANSI or Health Physics Society procedures modified, for measurements below 500 mR/h. Third, a field interlaboratory comparison of meters should be conducted with costs borne by the participants. Fourth, a need exists to establish a program for accreditation of low-level survey meters, although a sponsor for the program was not identified.
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NIST HOSTS WORKSHOP FOR MANUFACTURERS ON MEASUREMENTS AND STANDARDS FOR PROSTATE THERAPY SEEDS

In April 1999, the Medical Applications Subcommittee of the Council on Ionizing Radiation Measurements and Standards held a 1 day workshop at NIST on evolving needs for measurements and standards for radioactive iodine-125 and palladium-103 seeds used in prostate cancer therapy. Following reports in the national press last summer of promising results for 10 year clinical trials of radioactive seeds, there has been explosive growth in the number of procedures and the number of new manufacturers for these seeds. Since late 1998, NIST has performed calibrations for nine different seeds from seven manufacturers. This workshop addressed the urgent need for a public forum that included the seed and instrument manufacturers, the medical physics community, as represented by the American Association of Physicists in Medicine (AAPM), the federal regulators (Food and Drug Administration and Nuclear Regulatory Commission), and representatives from NIST. There were 42 participants in the workshop, representing 10 manufacturers, six medical centers, and three government agencies.
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NIST CO-SPONSORS PERSON AUTHENTICATION CONFERENCE

A NIST researcher along with scientists from a university, organized the Second International Conference on Audio and Video-Based Person Authentication. The conference was held in March 1999, in Washington, DC. The conference presented the latest results in face and speech recognition and in fusing signals from both modalities to recognize people. With the advent of inexpensive computers and cameras, combining video and audio is an active area of research that will have significant impact on the fields of face and speech recognition. The NIST scientist co-presented the paper "Analysis of PCA-based Face Recognition Algorithms." The paper presented results of a detailed experimental study of face recognition algorithms based on principal component analysis (PCA). PCA is a fundamental component of numerous face recognition algorithms.
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WORKSHOPS TO SUPPORT U.S.-EU MRAS

Representatives of the European Commission, in conjunction with the Food and Drug Administration and NIST, held a workshop in April 1999, for U.S. and Canadian entities desiring to be designated as Conformity Assessment Bodies (CABs) for medical devices under the U.S.-EU and Canada-EU Mutual Recognition Agreements (MRAs). A European training firm covered the overall requirements of the European Directive for Medical Devices and the specific requirements for entities to be designated as CABs. In addition to the EU, U.S., and Canadian sponsors, representatives of potential U.S. CABs participated.

In April 1999, the European Commission, in conjunction with the Federal Communications Commission (FCC) and NIST, held a workshop for U.S. and Canadian entities desiring to be CABs for telecommunications and electromagnetic compatibility (EMC) under the U.S.-EU and Canada-EU MRAs. The seminar, conducted by staffs of the European Commission, FCC, and NIST, covered the European Directives for Telecommunications and EMC and the specific requirements for entities to be designated as CABs.

After each of the training workshops, NIST conducted a public workshop on proposed requirements for recognition under NISTs National Voluntary Conformity System Evaluation program in each sector, soliciting public comment.
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IMPROVED SENSOR FOR POLYMER INJECTION MOLDING

A paper presented by a NIST scientist at the Society of Plastics Engineers (SPE) annual meeting received the SPE's Future Technology Award. The paper, "In Situ Measurement of Product Shrinkage During Injection Molding Using an Optical Sensor," describes the

development of, and measurements using, an optical sensor inserted into the mold cavity of a polymer injection molding machine. The sensor is a simple and inexpensive device consisting of a diode laser light source, optical fibers for light transmission, a sapphire window interfaced with the mold cavity, and a silicon diode photo detector. As light is transmitted into the mold, it reflects from any interface at which there is a change in the index of refraction, such as the interface between resin and sapphire window and the resin boundary with the mold surface. As the solidifying resin cools, it contracts and pulls away from the window or the wall of the mold, thereby yielding additional interfaces from which the light reflects. From the interference patterns of the reflected light the thermal contraction, product shrinkage, and rate of shrinkage can be meas-ured. The sensor can be used to detect asymmetric shrinkage when the two sides of a product shrink at different rates. Such asymmetric shrinkage can be an indicator of war page in the molded product. The simplicity of design that uses inexpensive components enhances the probability that R&D laboratories and processors will use the sensor to monitor molding operations.

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FIFTY-TWO ORGANIZATIONS TRY FOR NATION'S TOP AWARD FOR EXCELLENCE

Fifty-two U.S. organizations, including 4 large manufacturers, 11 service companies, 12 small businesses, and, for the first time, 16 education and 9 health care organizations, have submitted applications for the 1999 Malcolm Baldrige National Quality Award, the nation's premier award for performance excellence and quality achievement. This is the first year that not-for-profit education and health care organizations are eligible to apply for the award.

Applicants for the award must show achievements and improvements in seven categories: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and results. During the upcoming months, each of the 52 applicants will receive a minimum of 300 hours of review by the award's mostly private-sector examiners.

Companies passing an initial screening this summer will be visited by a team of examiners in the fall to verify application information and to clarify issues and questions. Every applicant receives an extensive feedback report highlighting strengths and opportunities for improvement.

Winners of the 1999 award are expected to be announced in November by President Clinton and Commerce Secretary William Daley after the award's examiners and judges make their recommendations.

For more information on the Baldrige National Quality Award, go to www.quality.nist.gov on the World Wide Web.

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NIST AND MAINE TEAM UP FOR TECHNOLOGY, ECONOMIC GROWTH

On June 10, 1999, Maine Governor Angus King Jr. and Acting Under Secretary of Commerce for Technology Gary Bachula signed a letter of partnership linking organizations in Maine with NIST in an expansion of current cooperative efforts. It is the first such partnership formed by NIST with a state and will serve as a pilot for possible expansion to other states if successful.

The partnership will strengthen existing ties between NIST and Maine organizations, such as the Maine Manufacturing Extension Partnership, a strong component of NIST's nationwide Manufacturing Extension Partnership.

Teams from Maine and NIST have identified several promising areas for expanding current relationships through a combination of formal and informal arrangements. Three of the areas that will be explored under this new partnership include:

- cooperative efforts with both NIST's Manufacturing Extension Partnership and Advanced Technology Program to design an infrastructure to maximize the economic impact of Maine's expanding funding for science and technology;
- optical measurement and technical assistance from NIST's Physics Laboratory for businesses in Maine using such technology for measurement and inspection, production process diagnostics, machine vision, and remote sensing; and
- a joint study of Maine small businesses to determine their understanding and use of the Baldrige criteria, and to identify opportunities for improving the criteria to encourage more use by small businesses.

Other initiatives cover the use of wood composite materials, research on other composites, assessing conformity to boost exports, and a weights and measures pilot project.

Maine and NIST officials will monitor progress on the new partnership and report annually on its status.

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NIST GATHERS VALUABLE GAS DATA FOR CHIP PROCESSING

In the competitive struggle to increase the processing efficiency and the quality of semiconductor wafers, U.S. industry must have reliable data for the properties of numerous gases used in chip processing. That's because mass flow controllers—which are critical to the processing of semiconductor wafers—must be calibrated differently for each of the more than 50 gases now in use. Complicating matters is the fact that many process gases are extremely dangerous to handle, making it impractical for the manufacturers of mass flow controllers to directly calibrate each controller for each type of gas.

To get around this problem, industry calibrates mass flow controllers using benign gases, such as nitrogen, and then fine tunes the calibrations with models that are based on approximations of the properties of individual gases. More accurate data about the gases needing calibration would reduce the degree of guesswork needed for these models.

Now, NIST is developing a comprehensive, reliable database for process gases. Agency researchers are gathering the data by measuring the speed of sound as it travels through gases. The technique yields accurate information about the heat capacity and the equation of state, which is used to determine the density of a gas from measurements of its temperature and pressure. Thermal conductivity, viscosity and diffusion constants also are derived from specialized acoustic measurements.

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AMENDMENTS FOCUS FASTENER QUALITY ACT (FQA), LESSEN BURDEN AND LEAD TO ENACTMENT

On June 8, 1999, President Clinton signed into law a series of amendments to the Fastener Quality Act of 1990 that make the legislation more focused and less burdensome. With these amendments, the law clearly establishes protections against the sale of mismarked, misrepresented and counterfeit fasteners while eliminating unnecessary requirements. Fasteners include screws, nuts, bolts and other devices used in critical products and systems such as automobiles, aircraft and tanks.

A five-month Commerce Department study requested by Congress was completed in February 1999. The study's results led the department to conclude that the number and magnitude of problems with fasteners are a fraction of what they were when the law was passed. Among the reasons identified for this quality improvement were advances in fastener manufacturing technology and better procedures for military and civilian federal procurement of fasteners.

The new law as amended reflects many of the recommendations made in the February report. These include: limiting coverage to only high-strength fasteners, encouraging the use of recognized industry quality assurance systems, and streamlining paperwork reporting by allowing companies to transmit and store reports electronically.

NIST will continue to operate a voluntary program to accredit fastener testing laboratories. Additionally, accreditation organizations may submit their own registration and accreditation guidelines to NIST if they choose not to follow International Organization for Standardization guidelines.

The text of the amended FQA can be downloaded from the World Wide Web at www.nist.gov/fqa. Additional information including the text of the February 1999 Commerce Department study of the FQA and a fact sheet detailing the major amendments in the final law is available at the same web site.
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NIST HELPS GIVE JAVA™ A BIGGER KICK

NIST mathematicians have made a significant contribution to scientific computing by spearheading an effort to make the popular Java™ programming language more useful for scientists and engineers. Java(TM), which began in 1995, is now in wide use on the World Wide Web and in embedded systems.

A change in Java™ proposed by a NIST-led working group eliminated a bottleneck that prevented scientists who used popular microprocessors such as the Intel Pentium® from running calculations at full speed.

The affected calculations involve floating point arithmetic—the kind of arithmetic favored by scientists and engineers who do massive number crunching to get good results. In floating point arithmetic, numbers are stored using scientific notation, which allows people to

use a tremendous range of values in their calculations. The storage method involved is different from that used in integer arithmetic, which involves storing all the digits in a number.

The changes in the latest version of Java™ allow floating point arithmetic calculations to run as much as 10 times faster on certain microprocessors. Sun Microsystems Inc. developed Java™ and released the new version earlier this year.

These changes to the Java™ floating point specifications are a result of recommendations made to Sun by the Java Grande Forum. The Forum is a consortium of business, academic and government participants who are interested in using Java™ for high-performance computing.

Two NIST mathematicians are co-chairs of the Forum's Numerics Working Group, which proposed the changes. Other working group members include representatives from universities and private companies.
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STANDARDS IMPORTANT TO DEREGULATING INDUSTRY

With restructuring of the electric power industry looming in all 50 states, NIST has initiated efforts to anticipate needs for measurement services and other technical support that may arise as the industry transitions from a system of monolithic utilities to a diverse collection of firms competing to generate, distribute, or meter the power that goes to homes and businesses.

In its role as the nation's measurement authority, NIST recently commissioned the Research Triangle Institute (RTI) to study technology trends in the generation, transmission and distribution sectors. RTI also will assess measurement and standards needs identified by power industry experts interviewed during the study. Results will be presented during a NIST-sponsored national conference on "New Challenges for Measurements and Standards in a Deregulated Electric Power Industry" which will be held on Dec. 6-8, 1999, at the Key Bridge Marriott in Arlington, VA.

Restructuring will mean more choices and more competition. Industry-wide adoption of standard measurement methods will help to assure reliable, high-quality service. Development of these standards could be an international matter, involving foreign manufacturers and service providers certain to vie for customers in the large U.S. market.

Topics to be addressed at the December conference include competitive metering, bulk power measurement, power quality, distributed generation, and communication and control technologies.

For more information on the content of conference sessions, contact James Olthoff, (301) 975-2431, james.olthoff@nist.gov. Information on registration is available at www.nist.gov/public_affairs/confpage/991206.htm, or by calling Lori Phillips Buckland, (301) 975-4513.
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NIST LED WORK ON AUTOMATED ANALYTICAL LABORATORY STANDARDS LEADS TO ASTM STANDARD

A new Laboratory Equipment Control Interface Specification (LECIS) soon will be available as ASTM Standard E1989-98. ASTM Committee E49 on Computerized Systems and Chemical and Material Information and Subcommittee E49.52 on Computerization of Analytical Sciences Data approved the LECIS standard last November. LECIS is a prescriptive control specification that describes the expected behavior of laboratory equipment designed to be incor-porated into automated systems for chemical analysis. LECIS is derived from work done under the auspices of the Consortium on Automated Analytical Laboratory Systems (CAALS)—a government-private sector joint venture to foster the development and application of chemistry laboratory automation standards. The Modular Control Architecture, the set of Behaviors for Device Control, the Common Command Set, and the High-Level Communication Protocol developed by CAALS were combined and harmonized with the General Equipment Interface Specification defined at Sandia National Laboratories to create LECIS.

For the first 6 years of this decade, NIST hosted CAALS. During this time 23 companies and other government agencies participated in the consortiums activities through cooperative research and development agreements and Interagency Agreements. Currently, several private-sector companies are developing LECIS implementations for laboratory robots and other automated equipment. Information on these and other LECIS-oriented activities can be found at www.lecis.org.
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AISC PUBLISHES DESIGN GUIDE FOR SEISMIC RETROFIT OF WELDED STEEL-FRAME BUILDINGS DEVELOPED BY NIST

The American Institute of Steel Construction (AISC), which issues the design standard for structural steel buildings, recently published comprehensive guidance

for the seismic retrofit of welded steel-frame buildings as part of its Steel Design Guide Series. The guide was developed by NIST in partnership with AISC and three leading universities in response to the large number of beam-column connections that failed during the 1994 Northridge, CA earthquake.

The project, led by a NIST scientist, was funded through an emergency supplemental appropriation provided by congress following the earthquake. It supports NISTs legislatively mandated role under the national Earthquake Hazards Reduction Program.

The design guide provides experimentally validated response prediction models and design equations for three promising retrofit concepts that shift loading from the brittle weld joints into the beams, thus enabling the structure to absorb the earthquakes energy in a non-brittle manner. It has undergone extensive review by leading technical experts in industry and academic and by several AISC technical committees, including research, specifications, and manuals and textbooks.

Use of the design guide will increase the safety of tens of thousands of similar buildings throughout the world. Upgrading 50 % of the existing buildings at $10 to $30 or more per square foot in "high" seismic regions of the United States alone is estimated to cost $2 billion to $5 billion.

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PORTION OF THE CHARGE NOISE IN SINGLE-ELECTRON TUNNELING (SET) DEVICES IS "HEALED" BY THERMAL CYCLING

SET devices are based on nanoelectronic devices operated at low temperatures, in which the motion of single electrons are sensed or controlled. They are of interest to NIST for standards of capacitance or electrical current and to the electronics industry as design rules continue to shrink.

A major difficulty with these devices is that trapped charges in the disordered materials surrounding the device can lead to offsets (the "charge offset"), which alter the behavior; there is also an associated time-dependent noise (the "charge noise"). One of the common (but not systematically studied) observations about the noise is that there is a transient enhancement in the noise directly after cooldown, which decays to the steady-state noise level after a period of order 1 week. This means that generally experimenters must wait this long after cooldown before the device performance is satisfactory. In a new set of systematic measurements on two devices extending over about 4 months, NIST scientists have discovered that this widely held belief is not strictly correct. In fact, it appears that this transient noise enhancement only appears for the first one or two cooldowns after fabrication, or after a high-temperature anneal, but that on subsequent cooldowns the device achieves its lower noise steady-state behavior immediately.

This observation may be related to the low-temperature dynamics in amorphous and glassy solids. In particular, there have been many observations of non-equilibrium heat evolution from amorphous materials, which decay with time after the cooldown. This behavior is driven by the two-level systems in amorphous materials. However, this long-observed phenomenon in amorphous materials will recur with each cooldown, in contrast to the results of the charge noise measurements; this difference is at present not understood.

An important possible implication of this work is that, after "training" the SET device by repeated cooldowns or a high-temperature anneal, it may be possible to use SET devices in applications without waiting for the 1 week equilibration time. This fact may be particularly useful for implementation of a portable capacitance standard, being developed at NIST.

Studies continue on the time evolution of the charge noise in SET devices, both to determine the range of conditions under which the thermal training is effective and to understand quantitatively the physical mechanisms that give rise to it.

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RESIDUAL STRESSES IN COLD-COILED AUTOMOTIVE SPRINGS

Among the most important components of an automobile suspension system are the springs. A major automobile manufacturer fabricates springs using a traditional hot-coiling process and a newer, cold-coiling process. Cold coiling offers several metallurgical and economic advantages over hot coiling, but as a process it is more complicated to control. One of the issues in the process control is the understanding of the development of residual stresses, which are those stresses retained in a body even after external influences are removed. The importance of residual stresses is in the fact that they add to applied stress and can effectively strengthen or weaken a component. In a recent collaboration between scientists from the automobile manufacturer and NIST, the complete residual stress field in a series of undisturbed

cold-coiled springs was determined with the help of neutron diffraction. This investigation has major impacts in at least two areas. First, it allows mechanical engineers to test and verify the models that they use to predict the residual stress field. Second, the minimum size of a removed spring piece that exhibits an undisturbed residual stress field was determined. The latter information will allow the automobile manufacturer to do a better, limited parameter study using the more accessible method of x-ray diffraction. However, in contrast to neutron diffraction, x-ray diffraction is restricted to measurement at or near the surface. Ultimately, this collaboration will help the automobile manufacturer better understand the process parameters for cold coiling of automotive springs.
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NIST APPLIES OPTICAL COHERENCE TOMOGRAPHY TO AUTOMOTIVE COMPOSITE

A new non-destructive imaging technique, optical coherence tomography (OCT), was used to characterize rapidly the distribution of flaws in a prototype composite part for the automotive industry. Due to the complex structure of the part, conventional imaging techniques were too cumbersome or expensive, and OCT provided a viable alternative. OCT combines a Michaelson interferometer and confocal optics to provide unprecedented signal-to-noise capability in samples with low optical transparency. The combination of resolution, speed, and cost make this technique an attractive alternative to conventional techniques based on ultrasound or x ray. NIST is developing the technique for use in composite and polymeric materials, in conjunction with a private company.

The automotive material was produced in a proprietary process in which the foam core and fiber-reinforced face sheets of a sandwich panel were molded simultaneously. The very high speed of the reaction kinetics combined with evolving rheology of the polymer precludes the application of existing processing models. Therefore, extensive characterization is required to understand the behavior of the process. OCT allowed NIST to acquire a volumetric data set of the composite face sheet and outer portion of the foam core in approximately 3 h, compared to several days required for conventional confocal microscopy. Comparison of the two data sets validated the porosity distribution found by OCT at a spatial resolution of roughly 20 μm.
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DEFECT STRUCTURES MEASURED IN DEFORMED METALS

NIST scientists have demonstrated that ultrasmall-angle x-ray scattering can be used to measure defect structures in deformed single crystals of aluminum. Using the NIST beam line at the National Synchrotron Light Source, scattering data that were consistent with their recent theoretical predictions were obtained, allowing them to quantify the distribution of defects in the deformed metal. Most previous attempts to measure defect distributions have used transmission electron microscopy (TEM). However, TEM requires metal samples that are reduced to thicknesses less than about 0.3 μm, and in such thin samples the deformation processes and defect structures are different from those in bulk material. The experiments used samples thick enough to behave like bulk material. The measurements of defect structures, and the supporting theoretical analysis, are helping the development of quantitative models for the behavior of metals subjected to large deformation. Such models are needed to predict efficient forming processes for industrial products such as automotive sheet metal.
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DIODE LASER COMPETENCE PROJECT BEARS FRUIT

NIST researchers incorporated a diode laser interferometer into atomic force microscope (AFM) measurements. They disabled the z-axis motions of one of their commercial AFMs and incorporated a new z-axis stage using a diode-laser-based Fabry-Perot interferometer. Under development for several years, the new stage is one component of the Diode Lasers for Length Measurement Project, a competence project now in its final year. For the first time, the researchers have a primary, traceable length standard that is fully integrated into the z-axis of a scanned probe microscope. No transfer standards or capacitance gages are involved in the data collection. Initial results on both 18 nm step-height standards and experimental 0.3 nm Si atom-step standards appear promising. These researchers measured a sample standard deviation of 40 pm at a 45 Hz Nyquist bandwidth as the AFM tip traversed across a Si step-terrace. With further work, they expect to measure Si atom-steps with a traceable uncertainty.
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MICROPATTERNING WITH HIGHLY CHARGED IONS AND SELF-ASSEMBLED MONOLAYERS

Efforts to improve the techniques for micropatterning surfaces have involved the use of either novel resists or new methods of resist exposure. In collaboration with chemists from a university, NIST physicists have done both: exposing a self-assembled monolayer (SAM) resist with a highly charged ion beam. The SAM is formed on a gold-coated silicon wafer in a solution of alkanethiol in ethanol. Such resists are very thin (approximately one nanometer) and smooth on a molecular scale, which makes them excellent candidates for high-resolution lithography. This resist is exposed with a beam of exotic ions produced with the NIST Electron Beam Ion Trap (EBIT). The ions used here, Xe^{44+}, have a potential energy of 51 keV that is released upon impact. Once exposed, the samples were etched in a solution that removed the gold beneath the exposed SAM, and transferred the pattern of damage from the SAM to the gold layer.

Using laser reflectivity to quantify the degree of etching, it was shown that these highly charged ions are over an order of magnitude more efficient at converting their potential energy to surface modification than are the metastable argon atoms used in previous studies. Furthermore, a Xe^{44+} ion has several thousand times the potential energy of a metastable argon atom and the deposition of this energy on the surface is localized in time (femtoseconds) and in space (nanometers). Because of the high-energy density resulting from a highly charged ion impact, as compared to that from a metastable argon ion impact, thicker and more robust SAMs (dodecanethiol) can be used. Using SAMs of dodecanethiol and a stencil mask, a demonstration of micropatterning using highly charged ions was performed. In this demonstration, the edge roughness was under 100 nm and was limited by the quality of the mask.

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ACCURATE "WEIGHING" OF GAMMA-RAY PHOTON LEADS TO AN IMPROVED VALUE OF THE NEUTRON MASS

NIST scientists have extended accurate crystal diffraction gamma-ray spectroscopy to the several MeV region where wavelength measurements contribute to the determination of atomic masses. In this region, the wavelengths are less than a picometer, and the mass associated with the gamma-ray photon is a significant fraction (a few times 10^{-3}) of an atomic mass unit, u. This connection between gamma-ray wavelengths and atomic masses has led to the use of the phrase "weighing" a photon. Two precision measurements are required: (1) crystal lattice spacing measurements, which are made at NIST, and (2) diffraction angle measurements, which are made at the high flux reactor of the Institut Laue Langevin (ILL) in Grenoble, France. The crystal lattice spacing measurements are a continuation of the long-standing crystal lattice spacing program championed by a NIST scientist. Silicon and germanium crystals whose lattice spacings are known in meters are used on a two crystal spectrometer to diffract gamma rays. The diffraction angles are measured with interferometers calibrated using an optical polygon. Although earlier gamma-ray measurements of long-lived sources were made at the NIST reactor, the gamma-ray program has moved to the ILL reactor because it is the only reactor in the world that has the facilities to produce prompt gamma rays. Accurate gamma-ray measurements in the high-energy region are particularly challenging because the diffraction angles are very small (<0.1°).

To measure the neutron mass, the reaction $n + p \rightarrow d + \gamma$ was studied in which the emitted gamma ray has an energy $E \approx 2.2$ MeV. The measured wavelength, $\lambda_{meas} = 5.57671299(99) \times 10^{-13}$ m, was corrected for nuclear recoil and converted to atomic mass units to obtain what is called the deuteron binding energy, $S(d)$. The above reaction rearranged for the neutron and expressed in atomic mass units is $m_n = [m(^2H) - m(^1H)] + S(d)$. Summing the gamma-ray measurement of $S(d)$ and the atomic mass measurement of $[m(^2H) - m(^1H)]$ produces the most accurate value for the mass of the neutron, $m_n = 1.00866491637(82)$ u, a relative standard uncertainty of 8×10^{-10}. The uncertainty of this measurement is one fourth the uncertainty reported in the 1995 Atomic Mass Evaluation. The improved value for the neutron mass means that precision gamma-ray measurements and precision atomic mass measurements both contribute with approximately the same uncertainty to the determination of atomic masses. Conversely, the neutron mass is an important quantity for predicting the binding energy of nucleons in the nucleus and providing a theoretical basis for the observed binding energies. In addition, this measurement impacts the determination of the fine structure constant obtained by measuring the wavelength and velocity of a free neutron.

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EVALUATION OF NIST-F1, A FOUNTAIN FREQUENCY STANDARD

NIST scientists have completed the first evaluation of NIST's newest atomic frequency standard, a cesium-fountain frequency standard. The new standard, NIST-F1, uses laser-cooled atoms that are tossed vertically through the microwave cavity and return under the influence of gravity to a detector below the level of the cavity. Because the atoms move at much lower speed, this standard suffers much smaller systematic frequency shifts than are found in atomic beam standards.

The relative standard uncertainty for this evaluation was 2.8×10^{-15}, about half that of NIST's atomic beam standard, NIST-7. This result is dominated by measurement noise, which should be reduced through improvement of the signal-to-noise performance of the standard. The relative uncertainty associated with systematic effects, particularly the collision shift, is estimated to be 1.1×10^{-15}. It is these effects that are expected to limit the performance of the device.

A simultaneous evaluation of NIST-F1 and NIST-7 demonstrated excellent agreement, well within the uncertainties for both devices. Despite the lower uncertainty of the fountain standard, NIST-7 will continue to be operated and evaluated until operation of the fountain becomes routine. This could be achieved as early as the end of 1999.

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NEW RADIOTHERAPY RADIONUCLIDE STANDARDIZED

Accurate measurements of the amount of radioactivity present in radiopharmaceuticals rely on standards developed by NIST. These standards are critical for ensuring accurate measurements of administered dose, determining reaction yields, and for normalizing dosimetry measurements. Moreover, a radioactivity measurement standard for new radiopharmaceuticals is required by the United States Food and Drug Administration prior to giving approval to the drug for human use. One such radionuclide that shows great promise for use in radiotherapy against cancer is the rare earth isotope ^{177}Lu ($t_{1/2}$ = 6.7 d). NIST has recently developed a new standard for this radionuclide, working in collaboration with a private company.

The radioactivity in each of several solutions was calibrated using $4\pi\beta$ liquid scintillation (LS) counting, with confirmatory measurements made with "4π" gamma-ray spectrometry. The expanded (k = 2) uncertainty on the activity measurements was 0.6 %. Impurity measurements were carried out using gamma-ray spectrometry and indicated that the only impurity present was the long-lived (160.4 d) ^{177m}Lu isomer at an activity level of approximately 0.03 % that of the ^{177}Lu, as of the reference time. Measurements then were carried out to determine a calibration factor for the NIST $4\pi\gamma$ ionization chamber that can be used to make rapid activity determinations of additional solutions that may be submitted.

Another result of these measurements was a new determination of the ^{177}Lu half-life. Based on ionization chamber measurements performed over the course of 27 d, the half-life was found to be 6.64 d $\pm$ 0.01 d. This value was confirmed with LS data collected over 15 d. Although the exact source of the discrepancy between the previously recommended value of 6.73 d $\pm$ 0.01 d and the present value is yet to be uncovered, incomplete accounting for the long-lived ^{177m}Lu isomer would definitely make the half-life appear longer.

Future work to be carried out by NIST will be the development of "transfer standards" that can be used to make fast, accurate measurements in hospitals and research laboratories. These standards will take the form of calibration factors for commercially available "dose calibrators" in geometries often encountered in the clinical setting. In addition, a measurement intercomparison for this radionuclide is planned for next fall between NIST and the Physikalisch-Technische Bundesanstalt.

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LARGE NUMBER OF CONFORMATIONAL ISOMERS EXPERIMENTALLY IDENTIFIED FOR SIMPLE ALKENES

Simple hydrocarbons, such as alkanes and alkenes, furnish ideal model systems for investigating the complex conformational dynamics found in biologically active molecules. Hydrocarbons have the advantage of having simple potential energy functions and a relatively small number of electrons. These two features combine to potentially make accurate molecular modeling predictions possible. NIST researchers recently have begun an investigation of the rotational spectra of the 1-alkenes from 1-pentene to 1-dodecane in a molecular

beam at arotational temperature of approximately 2 K using molecular-beam Fourier-transform microwave spectroscopy. The measurements provide data to test the ability of molecular mechanics and *ab initio* quantum chemistry to correctly predict the geometries and energy ordering of low-energy conformations of simple alkenes. The number of conformers for these systems is expected to grow approximately as 3^{n-2} for alkene C_nH_{2n} for increasing n. For 1-pentene they have been able to record the rotational spectra for four of the five conformers predicted theoretically while for 1-hexene they have observed seven of the 13 predicted conformers. This is particularly noteworthy as the samples have been cooled supersonically to 2 K. The larger alkenes, for which our studies have only just begun, are expected to display an even richer conformational chemistry. The preliminary results show that molecular mechanics potential functions and *ab initio* quantum chemistry provide reliable tools for predicting the conformations of small hydrocarbons.
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PLAN PRESENTED FOR INDUSTRY-LED EFFORT ON ASSESSMENT OF MACHINING MODELS

A NIST researcher attended the North American Manufacturing Research Congress to present the technical plan for the Assessment of Machining Models project (an industry-led, National Science Foundation-sponsored effort which includes several private companies and NIST). The goal of the project is to assess the current capability to perform predictive modeling of machining operations. This capability would allow industry to reduce the amount of empirical testing that must be done in order to develop a new machining process. The technical plan was well received, with approximately 30 academic and other research institutions worldwide interested in having the predictive capabilities of their models assessed.
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SMALL CLOCKS WORKSHOP

NIST, in cooperation with the U.S. Army, sponsored a 1 day workshop on small clocks in June 1999. Forty people attended the workshop, which was held in Boulder. A majority of the attendance was from industry. The focus of the workshop was on low-power, robust, compact, low-cost atomic frequency references for commercial, military, and instrumentation applications.

The application of such clocks to synchronization of the nodes of cell-phone networks was described. It was pointed out that the clock characteristics required for this application can barely be met by existing technology, and there is thus a need for the development of new technology for future systems.

A NIST scientist then described the development of a new rubidium Raman clock that might eventually meet such requirements, although additional development is still clearly needed. Other NIST scientists discussed the prospects for small fountain clocks, a technology now used for primary standards, but far from demonstration as a practical technology for small field-serviceable clocks, and the use of optically generated combs as microwave frequency references.
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NIST/AIST (JAPAN) HOLD FIFTH INFORMATION EXCHANGE

The Fifth Joint Information Forum on standards and conformity assessment issues took place in May 1999, with participation by NIST and the Japanese Agency of Industrial Science and Technology (AIST), Ministry of International Trade and Industry (MITI). The aim of these forums is to build a strong and lasting relationship for activities of mutual interest in the Asia-Pacific region and internationally.

AIST reported for the 1999 Information Exchange, As the world economy has become more globalized, standardization is becoming an increasingly important aspect as the rules of international transaction. We have entered the era of the global standard. The Standards Department of AIST intends to implement a timely standardization policy so that we can cope with international movements and the changing needs in our countrys society."

Forum participants exchanged information on mutual recognition of measurement standards, the U.S.-Japan Bilateral Cooperation, and the status of Mutual Recognition Agreements between the United States and the European Union. In discussions of conformity assessment, information was exchanged on ISO activities and the international committee on standards and conformity assessment. Updates were given on the National Cooperation for Laboratory Accreditation; the Organization of International Legal Metrology Mutual Agreement on Pattern Approvals; and recent activities of Asia Pacific Economic Cooperation (APEC), Pacific Area Standards Cooperation, and the APEC Subcommittee on Standards and Conformity. Japans current activities in these international programs were described.

NIST researchers expanded earlier presentations on U.S. and international standards activities for pressure vessels, iron and steel, welding, and color management-digital cameras and color scanners, including a report on how international standards for pressure vessels are adopted by the U.N. Committee of Experts on the Transportation of Dangerous Goods. AIST described current Japanese efforts and support for these standards.

A NIST researcher gave an overview of international efforts by the International Commission on Illumination, International Electrotechnical Commission (IEC), ISO, the International Telecommuni-cations Union, the International Color Consortium, and the IEC TC100/PT61966 Committee to develop international standards for color management problems. NIST's calibration facility for color measuring instruments for displays was also described. AIST presented Japan's metrology work in color management.

At the Office of the United States Trade Representative, the Japanese delegation was given an overview on U.S. policy and activities related to the World Trade Organization, Asia Europe Meetings, the Transatlantic Economic Partnership, and the Transatlantic Business Dialogue.

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NIST SPONSORS THIRD ANNUAL RADAR CROSS SECTION RANGE CERTIFICATION MEETING

A Radar Cross Section (RCS) Certification meeting was organized by NIST in conjunction with industry and the Department of Defense, and held in Boulder in March 1999. The meeting was co-hosted by the Air Force Research Laboratory, Wright-Patterson AFB, Dayton, Ohio. The purpose was twofold: (1) to hold discussions within the RCS measurement community, both industry and government, on RCS certification and measurement assurance issues, and (2) to update the RCS community on the progress of the Department of Defense demonstration program intended to certify three volunteer measurement ranges over the next year. Because of the potential impact of a certification program, the meeting was well-attended, with about 55 participants from both government and industry. About six RCS professionals from the United Kingdom also were present.

Discussions at the meeting were focused on the evaluation criteria for RCS range certification based on the ANSI/NCSL Z540 standards, on the certification process, and on RCS uncertainty analysis. Important small group meetings on technical issues also were held in parallel with the larger meeting. Volunteers were sought to serve on the RCS certification committee that will have the responsibility for reviewing the range books that document RCS organizational structure, RCS calibration and measurement procedures and RCS uncertainty analysis. The first review committee will be created sometime in 1999, and it is planned that the review process for certification will begin about July 1999.

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INTERNATIONAL ROUND ROBIN ON ERBIUM-DOPED FIBER AMPLIFIER MEASUREMENTS CONCLUDES

NIST has just concluded an international round robin comparison of erbium-doped fiber amplifier (EDFA) measurements.

EDFAs are critical components in wavelength-division-multiplexed optical communications because they can simultaneously amplify signals at many different wavelengths. Long distance communications systems may use many EDFAs, so knowing the characteristics of individual amplifiers is an important element of system design. Market impacts are large—approximately $2.2 billion of wavelength division multiplexing (WDM) equipment was sold in 1998, up 38 % from 1997.

This round robin, requested by the International Electrotechnical Commission, involved 19 participants from Europe, Japan, and North America. Participants measured subsets of six different EDFAs for output signal power, spectral gain, polarization dependent gain, optically measured noise figure, and electrically measured noise figure. The results show that the measurement of spectral gain is more difficult than expected, with typical standard deviations of 0.3 dB to 1.0 dB between participants and worst-case disagreements of about 5 dB. Measurements of noise figure gave typical standard deviations of 0.1 dB to 0.8 dB and worst-case disagreements of 4.0 dB. In both cases, the results showed significant systematic biases between participants. This suggests that artifact standards for spectral gain and noise figure will be able to improve measurement quality within the industry. NIST is currently developing EDFA transfer standards for these parameters that it expects to use in a Measurement Assurance Program.

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NIST ASSISTS IN THE DEVELOPMENT OF AN ICIA PILOT PROJECTION DISPLAY EVALUATION PROGRAM

Annually, at its INFOCOMM International Exposition, the International Communications Industries Association (ICIA) holds a "Projection Shoot-Out." The purpose of this shoot-out is to provide conference attendees a chance to judge the quality of projection displays. Comparisons of projectors are done side-by-side in a darkroom environment. Last year, a team was assembled to measure the light output of the 107 displays submitted to the shoot-out, and NIST was asked to provide technical consultation and support for the measurements.

ICIA decided, as a result of the success of the shoot-out, to set up a pilot program for projection display evaluation at an independent laboratory. Participating manufacturers send in displays for testing and receive ICIA accreditation if all requirements are satisfied. NIST again was asked to assist, this time as a technical advisor to the independent laboratory, in setting up the measurement facility. NIST gave recommendations on minimization of errors, improving measurement quality, and maintaining accuracy of the measurements. These recommendations were based on research performed at NIST. NIST staff acted only as technical consultants, not laboratory accreditors or assessors.

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INTERNATIONAL ROUND ROBIN FOR CREEP OF SILICON NITRIDE

Silicon nitride is the prime candidate material to replace superalloys for use at temperatures greater than 1200 °C in land-based gas turbines. Under these conditions, creep, or time-dependent deformation under load, can be the limiting factor for use. As such, accurate determinations of the high-temperature properties are necessary for design. The testing phase of the first round-robin for tensile creep of silicon nitride, organized and administered by NIST, has been completed. There were 14 participants, including Japanese, German, and Swiss laboratories as well as those from U.S. universities, and national laboratories. The participating laboratories represent a sizable fraction of the total laboratories in the world capable of conducting creep testing for the gathering of constitutive law data for silicon nitride. Analysis of preliminary results indicate that interlaboratory variability in measured properties can be large, in part due to the sensitivity of the material to test conditions. Furthermore, comparison of the several variants of test technique indicates that there may be an effect of specimen size on the measured properties, a finding that has significant impact for component designers.

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CARB HOSTS 29TH MID-ATLANTIC PROTEIN CRYSTALLOGRAPHY WORKSHOP

The 29th annual Mid-Atlantic Protein Crystallography Workshop was held in April 1999, at the Center for Advanced Research in Biotechnology (CARB) in Rockville, MD. This year's workshop was organized by two NIST scientists, along with a CARB professor. Fourteen crystallography-related companies underwrote the meeting expenses, many of them also presenting their latest products and tools. About 150 crystallographers from the Mid-Atlantic region attended.

The workshop began with a keynote lecture, "Cryo-electron microscopy plus X-ray crystallography: A hybrid approach to visualizing macromolecular interactions and transitions." This focus on combining crystallography with electron microscopy seemed appropriate, because many of the discussions and reports that followed were concerned with large macromolecular structures and complexes. It was clear that, with the trend toward larger problems, there is increasing need to combine crystallography with microscopy and other molecular imaging techniques. Another clear trend was toward utilizing the power of synchrotron radiation, especially as it enables multiwavelength-based phasing, which usually was accomplished by selenium substitution in the crystallized protein of interest. This method was used to determine several new protein structures that were reported at the workshop.

In the final session, there were three in-depth lectures/demonstrations on the topic of "High-Throughput Structure Determination."

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NIST REPRESENTED AT THE U.S. TAG MEETING FOR ISO TC 213

Three NIST researchers attended the semiannual meeting of the U.S. Technical Advisory Group to ISO Technical Committee (TC) 213 on Dimensional and Geometrical Product Specifications and Verification held in May in Albuquerque, NM. As part of this meeting, a special session was held to discuss the various approaches for describing and measuring the geometrical form of a surface and distinguishing the various regimes of surface topography: roughness, waviness, and form. The interpretation of surface form parameters and requirements can depend on whether ones technical background is from the tolerancing community or the surface texture measurement community. Significant progress was made toward finding a common ground for measurement procedures for the properties of straightness and cylindricity in particular.

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NIST PROVIDES A FORUM FOR EXCHANGE OF IDEAS ON HUMAN FACTORS AND THE WEB

NIST hosted the fifth in a series of human factors and the web conferences in June 1999, at NIST. About 300 representatives from industry, academia, government, and three foreign countries attended. These conferences, sponsored by private companies, provide a forum for sharing information among a community of human factors engineers, designers, and developers who are interested in producing web sites that are more useful and usable. Topics included cognitive strategies in web searching, the web event-logging tool, alternate behaviors for a web browsers back button, the Max model, globalization of user-interface web design, web macros, pervasive accessibility, web navigation, document design for effective electronic publication, and a case study in transforming a DOS-based mainframe system to the Internet. Two NIST researchers presented a paper on "The Effects of Cultural Markers on Web Site Use."
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NEW WEBSITE TELLS HOW NIST, PARTNERS "MAKE A CASE" FOR HISTORY

The Declaration of Independence, the Constitution and the Bill of Rights (on permanent display at the National Archives in Washington, DC) have guaranteed the rights and freedoms of Americans for more than 200 years. Since 1951, these great documents—known collectively as the Charters of Freedom—have been preserved in helium-filled cases created by NIST's predecessor, the National Bureau of Standards (NBS). Now, NIST, the National Archives and Records Administration, National Aeronautics and Space Administration, and a private company have teamed to design new state-of-the-art enclosures for the Charters of Freedom.

A new NIST World Wide Web site, www.nist.gov/charters, provides details on the current encasement project, the 1950s preservation work and the Charters themselves. Included are fast facts about the documents, specifications for the new encasements, a 1951 circular describing the technology behind the original project and a 1951 color video (in T1 and 56 K formats) showing NBS researchers sealing the Declaration of Independence into its case.

The website will be updated throughout the duration of the Charters encasement project, currently scheduled to end in 2003.
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PAPER DETAILS PROS AND CONS OF ANNEALING OPTICAL FIBERS

NIST has been a pioneer in the development of annealed optical fiber current sensors for use in commercial utility and power monitoring applications. Agency researchers discovered that annealing optical fibers enhances their ability to evaluate the behavior of electrical generators and the power transmission grid. Annealing a fiber involves raising the glass to a temperature above the strain point for a short time and then cooling it slowly back to room temperature. For instance, a fiber may be heated to a temperature of 850 °C for 8 h.

While this process reduces stress in the glass, it also initiates a number of physical and chemical changes in the glass which need to be understood and monitored. A new paper from NIST discusses these detrimental effects which include increasing the oxygen-hydrogen concentration in the glass and devitrification (the nucleation and growth of crystals) within the glass.

The paper states that to produce an annealed-fiber coil for utility company applications, the annealing process must be held within time and temperature bounds or the detrimental effects will degrade coil performance. On the other hand, devitrification may produce useful fiber components for other applications.

For a copy of paper 25-99, "Annealing Optical Fiber: Applications and Properties" by Allen H. Rose, contact Sarabeth Harris, MC 104, NIST, Boulder, CO 80303-3337; (303) 497-3237; sarabeth@boulder.nist.gov.
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NIST VIDEOS NOW JUST A CLICK AWAY

Over the past several years, NIST has produced a number of videos to better explain its partnerships, projects and programs for U.S. industry, as well as document important events in the agency's recent history Now, a showcase for these videos has been set up on the World Wide at www.nist.gov/videos.

Visitors to the site can sample videos with either a T1 line or 56 K modem, so downloading to a hard drive is unnecessary. Anyone without a video player can download one for free from the new NIST website. All programs eventually will be closed captioned for the hearing impaired. Longer programs (more than 15 minutes run time) are excerpted.

To obtain a VHS copy of any NIST video on the site, contact the Public Inquiries office at (301) 975-NIST (6478) or inquiries@nist.gov.
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